REPRODUCTIVE SUCCESS AND FORAGING BEHAVIOR OF THE OSPREY AT SEAHORSE KEY, FLORIDA

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Previous accounts have described the decline of reproductive success in the Osprey (*Pandion haliaetus*) (Ames and Mersereau 1964, Reese 1970, Wiemeyer 1971). With these reports in mind, I studied the breeding biology of Ospreys at Seahorse Key, Levy County, Florida. The principal aims of this study were to investigate the breeding biology of an Osprey population on an isolated marine island without serious pesticide problems (Blus et al. 1974). Included in the study are features of Osprey breeding behavior and feeding habits, and pesticide contents of Osprey eggs and food.

STUDY AREA AND METHODS

Seahorse Key is located approximately 4 km southwest of the town of Cedar Key on Florida's Gulf Coast, and is approximately 9 km from the mainland. Since 1936 when Seahorse Key became incorporated into the Cedar Keys National Wildlife Refuge, the breeding Ospreys, White Ibises (*Eudocimus albus*), Brown Pelicans (*Pelecanus occidentalis*), and other forms of wildlife have been protected.

Seahorse Key consists of 62.5 ha, 20.1 of which are mangrove swamp, 15.8 are in the littoral zone below mean high tide, and 26.6 include the beaches and upland areas (Wharton 1954). The key has large areas of mangrove swamp in which many mangroves were killed by freezes in January 1960, 1963, and 1966. The mangrove swamp includes principally black mangrove (*Avicenna nitida*), (90–95% of the mangrove area) with some white mangrove (*Laguncularia racemosa*) on the northern fringes and a rare occurrence of red mangrove (*Rhizophora mangle*) scattered throughout the swamps (Wharton 1954). The mangrove swamps, found exclusively on the mainland side of the island and lining its northern basins (Fig. 1), are in a period of regrowth, but each year fewer and fewer of the dead mangroves are strong enough to support the weight of an Osprey nest. The littoral zone has numerous shoal areas in the northern basins and on the southern side of the island that are used for fishing by the Ospreys. In addition, the east and west banks on the southern side of the key are heavily used by feeding Ospreys.

During the 1972 breeding season I checked each Osprey nest at least weekly, beginning on 6 March 1972 and ending on 30 July 1972. Nests were examined either by climbing or with the aid of a mirror on a long pole. Active nests were defined as those nests with eggs or, in those nests not readily observable, by the presence of young at the nest. Nest height from the ground or to sea level was measured with a steel tape and a mean height and standard deviation calculated.

Information on Osprey foraging behavior was obtained with binoculars and a stopwatch. Each fishing effort was timed from the moment an Osprey first was sighted until it captured a fish or was lost from view. Fishing efficiency was determined by the percent of fishing attempts resulting in fish capture.

Three eggs, each containing a rotten but well developed embryo, were taken from Osprey nests after these eggs had exceeded the normal incubation period by at least a

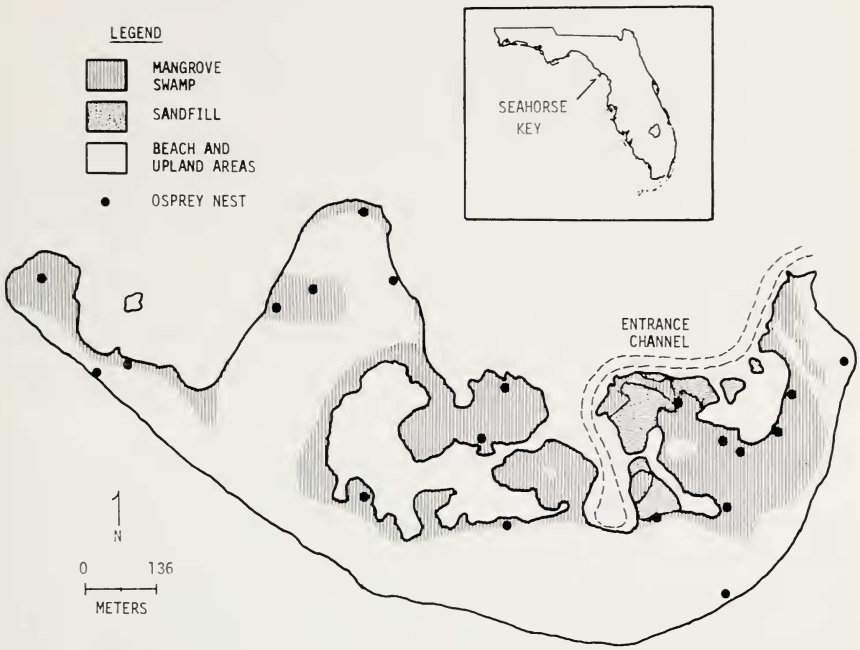

FIG. 1. Mangrove areas on Seahorse Key, Florida (modified from Wharton 1954) and location of Osprey nests in 1972.

week. Along with the eggs, 3 fish, somewhat dehydrated, were also retrieved from the same nests. Samples of fish muscle and homogenized egg contents were separately ground with sodium sulfate. Subsequently each sample was extracted with petroleum ether in a Soxhlet apparatus for 8 h. followed by acetonitrile partitioning and florisil clean-up. Using the silica gel-pentane separation technique of Snyder and Reinert (1971), the resulting sample was treated for the separation of polychlorinated biphenyls (PCB's) from DDT and its metabolites, and dieldrin. Analysis for the DDT components and dieldrin was performed on a Varian Aerograph model 600-D gas chromatograph using a column of OV 210 (6.4%) and OV 17 (1.6%) and operated isothermally (oven and detector at 209°C). The PCB analysis was performed on a Varian Aerograph model 2100 gas chromatograph using a similar column and operated with the oven at 206°C and the detector at 218°C.

RESULTS AND DISCUSSION

Reproduction.—During 1972 the 20 Osprey nests on Seahorse Key ranged in height from 2 to 14 m ($\bar{x} = 6.1 \pm 3.2$ m) with 85% of the nests on the north side of the Key (Fig. 1). The major factor determining Osprey nest height was the height of the dead black mangroves as 75% of the nests were in mangroves. Sixteen of the nests were below 8 m in height. The four

nests above 8.0 m in height were in living oak (*Quercus virginiana*) or cedar (*Sabina silicicola*). Two of these nests were inactive by 26 March 1972. Three nests in the mangroves were inactive by 3 April 1972; the remaining 15 nests were classified as being active.

Six closely observed nests had 3 eggs each with a hatching success of 44%. Three of the resulting hatchlings were lost in early May when 2 nest sites were destroyed by a storm. Eight of the 15 active nests produced a total of 11 fledglings.

Henny and Wight (1969) stated that each adult female in an Osprey population must produce between 0.95 and 1.30 young per nest each year in order to maintain a stable population. The 1972 production level at Seahorse Key of 0.73 young per nesting female was below that needed for a stable population. However, if not for the storm in May, production would have been 0.93 young per nesting female.

Foraging.—The Osprey preferred the shallow waters afforded by low tide for fishing. The birds fed mainly during the middle-late ebbing to the middle rising of the tide in the Cedar Keys area. They showed a definite preference for the shoal areas consisting of the East and West Banks and the shallow areas on the south side of the Key. The northern basins were used for fishing but not as extensively as the fishing grounds on the south side. The shallower waters in these areas before and after low tide were likely favorite areas for fishing because of the large numbers of speckled trout (*Cynoscion nebulosus*) and striped mullet (*Mugil cephalus*) that frequent them.

Despite their quick plunges, Ospreys required several strikes and many minutes to catch a fish (Table 1). Overall, adult Ospreys were successful in 58% of their fishing efforts. Ueoka and Koplin (1973) found that adult Ospreys in northwestern California were successful in 82% of their fishing efforts. At Seahorse Key, fish capture by adult Ospreys occurred on the first attempt in 52% of the 23 successful fishing efforts. Of the 17 unsuccessful fishing efforts, 7 (41%) involved Ospreys that flew back to the key without securing fish. The remaining 10 (58%) unsuccessful fishing efforts involved birds that were lost from view.

During the first week of flying, the young followed the adults to the shoal areas and attempted to fish for themselves. Twice adults used food as a method of coaxing the young to feed for themselves. An adult, carrying a fish, flew around the young and finally dropped it in mid-air, making it necessary for the young bird to dive quickly in order to catch it before it hit the water. In this manner the young were forced to retrieve the fish from the surface of the water until they finally started fishing by themselves.

TABLE 1

ANALYSIS OF FISHING EFFICIENCY OF ADULT AND FLEDGLING OSPREYS

	Adult	Young
No. fishing efforts	40	21
No. fish caught	23	6
Percent of fishing efforts successful	57.5	28.6
Attempts/catch	5.4 ± 6.7*	12.7 ± 7.2
Minutes/catch	38.3 ± 21.7*	77.3 ± 32.8
Percent of attempts resulting in a catch	18.6	6.3

* Mean ± standard deviation; Significant difference between adults and young at $P \leq 0.05$ using Student's T Test.

This account is similar to that of Meinertzhagen (1954) for the luring of young Ospreys to fish on their own.

Recently fledged Ospreys were less efficient at fishing than their parents. The young birds made more attempts and required a longer period of time to catch a fish than their more experienced parents (Table 1).

Ospreys at Seahorse Key fed primarily on speckled trout; of 103 food items identified, 64% were speckled trout. Of the remaining fish caught, 27% were striped mullet, 8% were sea catfish (*Galeichthys felis*), and 2% were ocellated flounder (*Amclopsetta quadrocellata*).

Eggshell thickness.—Seven samples of Osprey eggshells were obtained and sent to D. W. Anderson for measurement. The shells ranged in thickness from 0.38 to 0.53 mm with an average thickness of 0.46 ± 0.06 mm. Membrane thickness was 0.12 ± 0.01 mm with extremes of 0.11 and 0.14 mm. The calcite layer had an average thickness of 0.34 ± 0.06 mm with the values ranging from 0.24 mm to 0.40 mm.

Anderson (pers. comm. in 1972) reports a "normal" value for Osprey eggshell thickness as 0.50 ± 0.01 mm in 20 eggs from Florida (specific location and dates not provided). The mean membrane thickness was 0.13 mm, and the mean calcite layer thickness was 0.37 mm. Prior to 1947 average shell thickness in Eastern United States Ospreys was 0.505 ± 0.004 mm (Anderson and Hickey 1972). These data suggest that Osprey eggs at Seahorse Key were 8 to 9% thinner than "normal," though interpretation of shell thickness is made difficult by lack of knowledge concerning stage of embryo development of eggs measured.

Pesticide analyses.—Three Osprey eggs and 3 fish samples taken from active nests were analyzed on a lipid weight basis to determine organochlorine pesticide and PCB residues. The eggs contained an average concentration of 8.34 ± 1.45 ppm of p,p'-DDE, 3.55 ± 0.24 ppm of p,p'-DDD, 0.30 ± .02

Table 2

DDT Compounds, Dieldrin, and Polychlorinated Biphenyls in Osprey Food Fishes (in ppm lipid basis)

Sample	p,p'-DDE	p,p'-DDD	p,p'-DDT	Dieldrin	PCB
Fish 1*	0.08	0.00	0.05	0.00	3.45
Fish 2*	1.82	0.00	4.54	0.00	227.30
Fish 3*	0.07	0.03	0.09	0.02	2.65

* Fish 1 = sea catfish, Fish 2 = ocellated flounder, Fish 3 = speckled trout.

ppm of p,p'-DDT, 0.26 ± 0.02 ppm of dieldrin, and 29.9 ± 6.7 ppm of PCB (Aroclor 1254). The fish contained low levels of organochlorines and only one, a sample of ocellated flounder contained high levels of PCB's (Table 2).

Pesticide and PCB burdens in Osprey eggs and their food fishes have been reported by several investigators (Dustman et al. 1971, MacCarter et al. 1969, Stickel et al. 1965, Wiemeyer et al. 1975). DDE residues found in Connecticut Osprey eggs were 254 ppm (lipid weight) (converted from wet-weight by using the fact that fresh Osprey eggs contain up to 3.5% lipid, Wiemeyer pers. comm.), and in Maryland Ospreys DDE residues were 69 ppm, (lipid basis). Residues in eggs from Seahorse Key were much lower than these. Similarly, Connecticut Osprey eggs contained an average of 17 ppm (lipid weight basis) of dieldrin as compared to only .26 ppm dieldrin in Seahorse Key Osprey eggs. Dustman et al. (1971) reported a median concentration of PCB's of 15.9 ppm (wet-weight basis) (approximately 454 ppm on a lipid basis) from eggs in Connecticut. Thus the 3 Osprey eggs from Seahorse Key contained low pesticide and PCB burdens.

Duke et al. (1970) report Aroclor 1254 from the water, sediment, and biota of Escambia Bay, Florida. The Aroclor content in the water from Escambia Bay was < 1 ppb. Their study showed biological magnification of Aroclor 1254 in a food chain: sediment contained < 0.3–1.7 ppm; crustaceans contained 1.0–7.0 ppm; fish contained 415–184 ppm. It is of interest to note that the PCB concentrations of their fish (including species examined in the present study) were similar to those in the fish taken from Osprey nests at Seahorse Key (Table 2).

There is, finally, no concrete evidence to suggest that any of these chlorinated hydrocarbon residues played any significant role in influencing hatching success of these birds especially since eggshell thicknesses of these birds were near "normal."

SUMMARY

During 1972 there were 15 active Osprey nests on the 62.5 ha of Seashorse Key, Florida. The Osprey population on this key produced 0.73 young per nesting female which is below the 0.95 to 1.30 young per nesting female necessary to maintain a stable population. Adult Ospreys were successful in 18.6% of their fishing attempts. The fishing technique of the Osprey is at least a partially learned behavior: adults required only 5.4 attempts per catch and 38.3 min per catch, but the young required 12.6 attempts and 77.3 min per catch.

Pesticide analyses of 3 osprey eggs indicated low levels of organochlorines and PCB's. Eggshells ($n = 7$) were approximately 9% thinner than shells collected prior to 1947.

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REQUEST FOR ASSISTANCE

Purple Martin color-marking.—A large scale continent-wide Purple Martin color-marking project was initiated in 1977. Observers are asked to look for and report any color-marked (plastic leg bands and/or wing tags) Purple Martins. Please record the color of the bands or wing tags, which leg they are on, age and/or sex (if either is known), where and when observed, and whether the bird was in a roost, staging flock, migratory flock, or at a nest site (scouting or nesting?). We are especially interested in the movements of young birds and their return to the parent colony or nearby colonies. All reports will be acknowledged and should be sent to Ms. Kathleen Klimkiewicz, Bird Banding Laboratory, Laurel, Maryland 20811.